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Feature Article

# Effects of social activation and physical mobilization on sleep in nursing home residents

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ABSTRACT

Age-related changes in sleep physiology, frequent occurrence of health impairments, and a sedentary lifestyle make nursing home residents particularly vulnerable to sleep disturbances. Despite the high prevalence of sleep disturbances in nursing homes, there is a lack of research concerning the use of non-pharmacological approaches for improving residents' sleep. This study aimed to promote residents' sleep by improving their social activation and physical mobilization. An experimental group of residents attending an activation program four times a week during an eight-week study course was compared to a non-treated control group in a cluster-randomized intervention trial among 85 residents of 20 nursing homes. Sleep was assessed by the Insomnia Severity Index (ISI), nurses' ratings of residents' sleep disturbances and actigraphy-based sleep parameters. Although no changes in actigraphy-based sleep parameters were observed, the subjective sleep quality ratings of the intervention participants significantly improved compared to the control group members ($p = 0.004$). This study suggests that physical mobilization and social activation may improve residents' subjective sleep quality. Further efforts to improve residents' sleep by increasing their physical and social activity should consider existing obstacles to encourage participation and adherence to the program.



Sleep disturbances are highly common among elderly adults living in nursing homes.[1] An age-dependent predisposition, medical and psychiatric illness and inactive behavior contribute to the high prevalence of sleep problems among residents.

## Changes in sleep with age

With increasing age, total sleep time and, especially, time spent in deep sleep decreases. The physiology of sleep in elderly adults is characterized by fragmentation, more frequent nocturnal awakenings, and a tendency for daytime napping. Elderly adults show a tendency to spend more time in bed, even in daytime, without using the time in bed for sleeping efficiently.[2,3]

## Medical and psychiatric conditions

In addition to altered sleep patterns, elderly adults are at higher risk of developing diseases or medical conditions that are highly comorbid with sleep disturbances. Late life insomnia frequently occurs in association with a neuropsychiatric illness, such as dementia, depression, or anxiety disorders.[1,4,5] Somatic conditions, such as cardiovascular diseases, chronic pain and nocturia, which become more prevalent with increasing age, may also cause sleep disturbances. Because of high morbidity, they often use multiple drugs concomitantly. Polypharmacy increases the risk of using stimulating drugs, which may also negatively affect the quality of sleep.[6]

## Environmental conditions contributing to sleep disturbances

In nursing homes, there are additional environmental and institutional factors that may also contribute to residents' poor sleep. Living in a nursing home encourages inhabitants to have an inactive lifestyle characterized by a lack of physical activity, little social contact, and extended time spent in bed. During the daytime, residents often spend limited time outdoors, causing bright

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light exposure to be reduced as a result.[6,7] Daylight, as well as physical and social activities, are crucial time cues (Zeitgeber) that help regulate the sleep-wake rhythm by strengthening the entrainment of the circadian pacemaker in the suprachiasmatic nucleus (SNC). This circadian system synchronizes the internal sleep-wake rhythm with local day and night times based on the perception of external stimuli. This system functions as a "biological clock," causing tiredness at approximately the same time in the evening. In addition to the circadian system, the homeostatic sleep drive is the second important sleep regulation mechanism. The homeostatic sleep pressure progressively increases during wakeful activities.[5] A lack of physical mobilization and social contact in residents' lives often results in the flattening of their circadian rhythm and reduced need for sleep in the evening.[6] Therefore, a promising approach to treating insomnia in the elderly is to compensate for the lack of environmental cues by offering additional physical exercise or social activation. Compared with a medical treatment for sleep disturbances, this approach has various advantages and no side effects and may sustain sleep improvement over time if a persistent alteration in residents' behavior succeeds.

## Promoting residents' sleep by activation

Alessi et al[8] evaluated the effects of physical activities on sleep quality in nursing home residents and found that sleep efficiency (percentage of time in bed spent asleep) improved with an activation program lasting 14 weeks. In another study, subjective sleep quality in older adults was enhanced by morning and evening structured activity sessions.[9] A study that evaluated the impact of an individualized social activity intervention on dementia residents' sleep documented a reduction in daytime napping and an improved day/night sleep ratio among intervention participants.[10] The results of a recent trial suggest that it might be particularly promising to offer the residents a combined intervention comprising physical exercises with social activity. Richards et al[11] achieved a statistically significant improvement of residents' total sleep time (TST) from 302.8 min at baseline to 362.2 min at follow-up in intervention participants compared to a virtually unchanged TST in a "usual care" control group (341.8 min at baseline and 340.4 min at follow-up; $p = 0.01$). The combined intervention comprised strength training or walking five days a week and social activity five days a week. In contrast to the combination therapy in the Richards et al study, the monotherapy branches of physical mobilization or social activation alone each failed to establish significant effectiveness.

However, the intensive and complex intervention by Richard et al may not be feasible in daily nursing home care. The intervention program lasted one and a half hours to almost 2 h each day five days a week. Furthermore, pneumatic fitness machines, which are usually not available in nursing homes, were used for the physical exercises. Additionally, the individualized social program placed high demands on the nursing facilities because 113 different activities were offered to the participants.

Therefore, we see a need to design and evaluate an intervention that could actually be replicated in real world settings. The intervention was aimed at improving residents' sleep quality by offering social and physical group activities lasting 45 min four times a week during an eight-week study course. The rationale behind the intervention was to maximize sleep duration and minimize sleep latency and nocturnal awakening by enhancing homeostatic sleep drive and strengthening the entrainment of the circadian rhythm.[10]

## Methods

### *Study centers*

This cluster randomized intervention trial was intended for long-term care facilities in the Berlin area with a capacity of more than 50 beds and facilities that were not specialized or restricted to a particular care need. Nursing home facilities were enrolled in the study from April 2012 until May 2013. A block randomization scheme was used to allocate the cooperating nursing homes either to the intervention group or to the control group by chance. An independent third party generated the randomization sequence inaccessible to the research team. An internet-based random sequence generator, random.org, was applied to a one-to-one allocation using block sizes varying between two and six.

### *Participants*

Residents were eligible to participate in the study if they had difficulty falling asleep or staying asleep or suffered from non-restful sleep at least once a week as assessed by the nurses. Additionally, they could only have mild to moderate cognitive impairment according to the MDS Cognitive Performance Scale,[12] and they had to be physically able to participate in the exercise program. Furthermore, various medical conditions were considered exclusion criteria (e.g., recent heart attack, acute heart failure, coronary artery disease with unstable angina, aortic stenosis, severe COPD and phlebitis/thrombosis in the last four weeks), which prevented residents from participating in the trial. Nurses from the participating care facilities acted as persons of trust and gatekeepers. They preselected potential study participants according to the inclusion and exclusion criteria of the trial and established contact between interested residents and the research team. After verification of study eligibility and signing an informed consent form, the residents were enrolled in the study. A medical certificate from the attending physician was obtained for all members of the intervention group at baseline to ensure that participation in the training was without health risk.

Sample size calculation accounted for cluster-randomization by an estimated variance inflation factor of 1.7, assuming an intraclass correlation coefficient (ICC) of 0.05.[13,14] According to Alessi et al[8] who had managed to increase sleep efficiency of nursing home residents by approximately one-tenth in a non-pharmacological trial, it was determined that the study needed 204 participants to detect an improvement of 10% in sleep efficiency with a power of 80% using a two sided test at $\alpha = 0.05$.

### *Physical and social activation program*

The activity program included two sessions of social activity and two sessions of physical training spread across four days each week during an eight-week study course (see Table 1). One session lasted 40–45 min, and there was always at least one day of rest between two physical training sessions. Social and physical activation were provided by qualified occupational and physical therapists, respectively, to groups of three to eight residents. Group activities, exercises to promote memory, fine motor skill games, and conversations were part of the structured social activity program. An occupation-based and client-centered approach was adopted in the social activity program to promote residents' communication and social interaction skills. In the physical training, study participants performed exercises to promote balance, strength, and endurance using small-scale gymnastic equipment, including Swiss balls,

**Table 1**
Overview of social and physical activity provided to intervention group members.

| | |
|---|---|
| Social activation | Social activity comprised group sessions lasting 45 min on two days a week for eight weeks. During a session, activities promoting cognitive skills, fine motor skills and creative skills, as well as parlor games and group discussions, were offered. |
| Physical exercises | Physical exercises comprised training sessions on two other days a week for eight weeks. One session lasted 45 min and was structured as follows: |
| 5 min | Warm up. |
| 15 min | Miscellaneous balance exercises while standing, while walking and using small-scale gymnastic devices. Each exercise was performed for 10–30 s. |
| 5 min | Relaxation exercises. |
| 15 min | Muscle strengthening exercise including wrist curls, arm curls, arm stretching, shoulder lateral raises, shoulder press, hip extension, knee curls, knee extension, leg raises. Six exercises were repeated ten times using wrist and ankle weights. |
| 5 min | Cool-down phase. |

skipping ropes, tennis rings, dumbbells, and ankle weights. The physical exercises were adapted from established fall prevention programs for older adults.[15] Participants in the control group continued to receive their usual therapies and routine nursing home activity during the study.

## Measures

### Actigraphy

During the study, sleep was measured by actigraphy at the following three time points: before intervention (at baseline), after four weeks at follow-up 1 (FU 1), and after eight weeks of the intervention at follow-up 2 (FU 2) (see Table 2). Participants in the control group were measured at the same time points. The actigraph, a wristwatch-sized device, detects movements by a motion sensor (accelerometer) and stores the generated signals on a memory chip. After transferring the recorded activity data to a computer, the data can be analyzed by algorithms able to distinguish sleep from wakefulness. At each time point, the study participants wore an Actisleep-monitor, manufactured by Actigraph LLC, on the wrist for an average of five nights and days (range 2–8 days). The study participants were provided with the same device for each measurement and were requested to wear the sleep monitor every time on the same side (preferably on the non-dominant arm). While wearing the actigraphs, residents documented the times of going to bed and getting out of bed in a sleep log. If they were not able to record these data themselves, nurses kept the sleep log instead. The devices were initialized to sample actigraphy data at a rate of 30 Hz. The data were analyzed using ActiLife 6.6.1 (Actigraph) software.

### Actigraphy-based sleep parameters

Sleep parameters were calculated using the Cole-Kripke Algorithm provided by the ActiLife 6.6.1 software. Based on the sleep logs and the activity data, we determined time in bed, sleep duration (total nocturnal sleep time), sleep efficiency (percentage of time in bed asleep) and sleep fragmentation outcome variables (wake after sleep onset, number of awakenings, mean awaking length, and mean sleep period duration). Sleep parameters were calculated based on actigraphy data averaged for each participant during a monitoring period. Actigraphy is perceived as a feasible technique for determining sleep and wakefulness in nursing home residents. A validation study in the nursing home setting comparing actigraphy with electroencephalogram (EEG) for monitoring sleep revealed correlations of $r = 0.91$ for total sleep time and $r = 0.78$ for sleep efficiency.[16]

**Table 2**
Baseline characteristics of the study population.

| | Intervention group | Control group | *p* value |
|---|---|---|---|
| Residents | 32 | 53 | |
| Female | 23 (71.9) | 42 (79.2) | 0.598 |
| Mean (standard deviation) age (years) | 83.9 (9.3) | 83.8 (8.0) | 0.960 |
| Cognitive Performance Scale (CPS scores 0–6) | | | 0.006 |
| Intact (0) | 12 (37.5) | 37 (69.8) | |
| Cognitive impairments present (≥1) | 20 (62.5) | 16 (30.2) | |
| Depression Rating Scale (scores 0–14) | | | 0.846 |
| Indication of depression (≥3) | 12 (37.5) | 21 (39.6) | |
| Aggressive Behavior Scale (scores 0–12) | | | 0.394 |
| None (0) | 23 (71.9) | 43 (81.1) | |
| Moderate to severe (1–5) | 9 (28.1) | 10 (18.9) | |
| ADL-score (scores 0–28): Mean (standard deviation) | 7.5 (7.0) | 6.1 (6.7) | 0.372 |
| Cardiovascular disease | 25 (78.1) | 46 (86.8) | 0.369 |
| Disease of the musculoskeletal system | 13 (40.6) | 23 (43.4) | 0.825 |
| Sleep related breathing/moving disorders | 5 (15.6) | 3 (5.7) | 0.249 |
| Sedative drug load (≥2) | 26 (49.1) | 18 (56.2) | 0.655 |
| Physical therapy/training (1 day a week) | 13 (40.6) | 24 (45.3) | 0.822 |
| Occupational therapy/leisure activities (2 days a week) | 14 (26.4) | 12 (37.5) | 0.335 |
| Difficulties falling asleep or staying asleep | | | 0.561 |
| Not exhibited in last 30 days | 8 (25.0) | 16 (30.8) | |
| Exhibited up to five days a week | 21 (65.6) | 28 (53.8) | |
| Exhibited daily or almost daily (6 or 7 days a week) | 3 (9.4) | 8 (15.4) | |
| Non-restful sleep | | | 0.487 |
| Not exhibited in last 30 days | 24 (75.0) | 36 (69.2) | |
| Exhibited up to five days a week | 8 (25.0) | 13 (25.0) | |
| Exhibited daily or almost daily (6 or 7 days a week) | 0 | 3 (5.8) | |
| Insomnia Severity Index (scores 0–28) | | | 0.337 |
| Not clinically significant (0–7) | 12 (41.4) | 18 (36.7) | |
| Subclinical insomnia (8–14) | 11 (37.9) | 26 (53.1) | |
| Moderate insomnia (15–21) | 5 (17.2) | 5 (10.2) | |
| Severe insomnia (22–28) | 1 (3.4) | – | |

Absolute frequencies and relative frequencies (values in parentheses) are given, if not otherwise stated.

### Insomnia Severity Index

In addition to determining sleep parameters by means of actigraphy, study participants were asked to rate their sleep quality at each measurement using the Insomnia Severity Index (ISI).[17] This self-assessment questionnaire comprises seven items covering the following domains: difficulties falling asleep, difficulties staying asleep, problems with waking up too early, satisfaction with current sleep patterns, effects on daily functioning, noticeability to others, and subjectively experienced stress due to sleep problems. The seven items are rated on a five-point scale and subsequently added to give a sum score that ranges from 0 to 28. Scores between 0 and 7 indicate no clinical significance, 8–14 indicate subthreshold insomnia, 15–21 indicate moderately severe clinical insomnia, and scores between 22 and 28 represent severe clinical insomnia. A recent psychometric evaluation study demonstrated good internal consistency (Cronbach's alpha of 0.9) of the ISI and good convergent validity ($r = 0.8$) with the Pittsburgh Sleep Quality Index (PSQI).[18]

### Nurses' ratings of sleep disturbances and baseline variables

Additionally, external ratings of sleep disturbances were provided by nurses at baseline and after eight weeks at FU 2. Sleep disturbances were operationalized as difficulties falling asleep or staying asleep using an item from the Minimum Data Set (MDS) of the Resident Assessment Instrument (RAI).[19] Sleep disturbances were judged by this MDS item as not exhibited in the last 30 days (0), exhibited up to five days a week (1) or exhibited daily

or almost daily (six or seven days a week) (2). Non-restful sleep was assessed by nurses at baseline using the MDS-Item "unpleasant mood in morning" as a surrogate marker on the same scale.

In addition to the sleep-related items, further MDS-based scales were used for baseline characterization of the study participants. The capacity to fulfill basic tasks of daily living was measured by the ADL Long Form scale.[20] This scale is non-weighted with scores from 0 (individual capacity is fully intact) to 28 (very severe impairment). In a validation study, ADL-items in the MDS showed correlations from $r = 0.58$ to $r = 0.78$ with the Physical Self-Maintenance Scale.[21] Cognitive impairments were assessed by the seven-point Cognitive Performance Scale (CPS).[12] The algorithm of the CPS combines five MDS-items to produce a score that ranges from 0 (intact) to 6 (very severe cognitive impairments). Compared to the Mini-Mental-State-Examination (MMSE), a commonly used screening tool for cognitive impairments, the CPS exhibited correlations of $r = 0.68$[22] and $r = 0.71$.[23] Negative mood symptoms were assessed using the MDS-based Depression Rating Scale (DRS). This screening instrument added seven items of a 15-point score ranging from 0 (no negative mood symptoms exhibited in the last 30 days) to 14 (all seven negative mood symptoms exhibited daily or almost daily). A score of three or higher indicates the suspicion of a depressive disorder.[24] The instrument was validated by the authors of the scale by comparison to two established scales. In a sample of 83 nursing home residents, the DRS revealed a correlation of $r = 0.7$ with the Hamilton Depression Rating Scale and $r = 0.69$ with the Cornell Scale for Depression.[24] The Aggressive Behavior Scale (ABS) was used to quantify the occurrence of verbal abuse, physical abuse, socially disruptive behavior, and resistance of care.[25] The scale ranges from 0 to 12, with higher values indicating more frequent and more severe aggressive behavior. The authors of the scale validated the instrument in a sample of 214 nursing home residents and found that the ABS was highly correlated ($r = 0.72$) with the Aggressive Subscale of the Cohen Mansfield Agitation Inventory (CMAI).[26]

Additionally, the diagnoses and medications of study participants were documented at baseline. A sedative load model was used to account for the cumulative effect of sedative drugs in the statistical analysis.[27] Depending on their sedative properties, prescribed medications were rated as 2 (e.g., benzodiazepines, tricyclics, conventional antipsychotics), 1 (e.g., atypical antipsychotics, antiepileptics), or 0 (non-sedating drugs) for this purpose. Thereafter, the scores were added to give a sedative drug load index. Furthermore, the frequency of residents' participation in regular social and physical activities in the nursing homes was documented.

### *Ethics*

The study was approved by the ethics commission of the Alice Salomon University and by the data protection official of Berlin. Before the start of the study, participants and their legal guardians (if necessary) were informed about the study in detail in written and verbal form by project team members. Written consent by the residents and their legal guardians (if necessary) was mandatory for study participation.

### *Statistical analysis*

Categorical variables were summarized by absolute and relative frequencies. Continuous variables were characterized by means and standard deviations. Baseline comparability of study groups was examined using *t*-test for continuous variables and exact chi-square test for categorical data. Exact chi-square tests were also used for comparing the number of participants with positive changes since baseline in nurses' ratings of sleep quality between study groups. Only participants with suboptimal ratings at baseline were included in this analysis. Intraclass correlation coefficients were estimated for actigraphy-based sleep parameters and for the ISI-score by means of analysis of variance using baseline data only. A multilevel model for longitudinal data was applied to the actigraphy-based sleep parameter and self-rated sleep quality measured by the ISI. Modeling nursing homes as a random effect in a "random intercept and slope as outcome model" accounted for clustering. Residents were also modeled as a random effect, considering autocorrelation between time points. Measurement points were managed as a random slope in these analyses. Raw-unadjusted and covariate-adjusted modeling was conducted. The adjusted model was controlled for gender, age, cognitive impairments, mood, aggressive behavior, ADL score, cardiovascular disease, presence of cardiovascular diseases, diseases of the musculoskeletal system, sleep related breathing/moving disorders, sedative drug load, and participation in regular social and physical activities in the nursing home. All residents who had at least a baseline measurement and a follow-up measurement at FU 2 were included in the intention-to-treat analyses, regardless of adherence to protocol. Two-sided *p*-values less than 0.05 were considered statistically significant. Statistical analyses were performed using SAS version 9.3.

## Results

### *Study participation*

The flow of nursing homes and residents through the study course is outlined in Fig. 1. Of the 102 nursing homes assessed for eligibility, 32 facilities agreed to participate and were randomized into equal groups (see Fig. 1). Nine nursing homes that were allocated to the intervention group and three nursing homes that were allocated to the control group withdrew from the study after randomization mainly due to a lack of residents eligible for and interested in study participation. 169 (6.5%) of 2582 residents of the 20 nursing homes that continued to participate fulfilled the inclusion and exclusion criteria according to the nurses' judgment and were willing to be contacted by the study team for further information. Finally, 107 residents agreed to participate, and the study was conducted with 49 residents from seven nursing homes assigned to the intervention and 58 residents from 13 nursing homes assigned to the control group. During the study course, 17 residents that were allocated to the intervention and five residents that were allocated to the control group dropped out of the trial. Therefore, the data of 85 study participants were available for statistical analyses (32 members of the intervention group and 53 members of the control group). The attendance rate of the intervention group members was 83.2% at the social activation sessions and 77.6% at the physical exercises.

### *Baseline characteristics*

Baseline characteristics of the participants in the intervention and control groups are shown in Table 2. Study participants were predominantly women (71.9% of the intervention group and 79.2% of the control group), and they were slightly older than 80 years (intervention group: 83.9 ± 9.3; control group: 83.8 ± 8.0). The intervention group had more cognitively impaired participants compared to the control group (62.5% vs. 30.2%; $p = 0.006$). Apart from cognition, there were no significant differences between the study groups regarding the other covariates at baseline. Treatment divisions were also balanced with respect to self-reported sleep

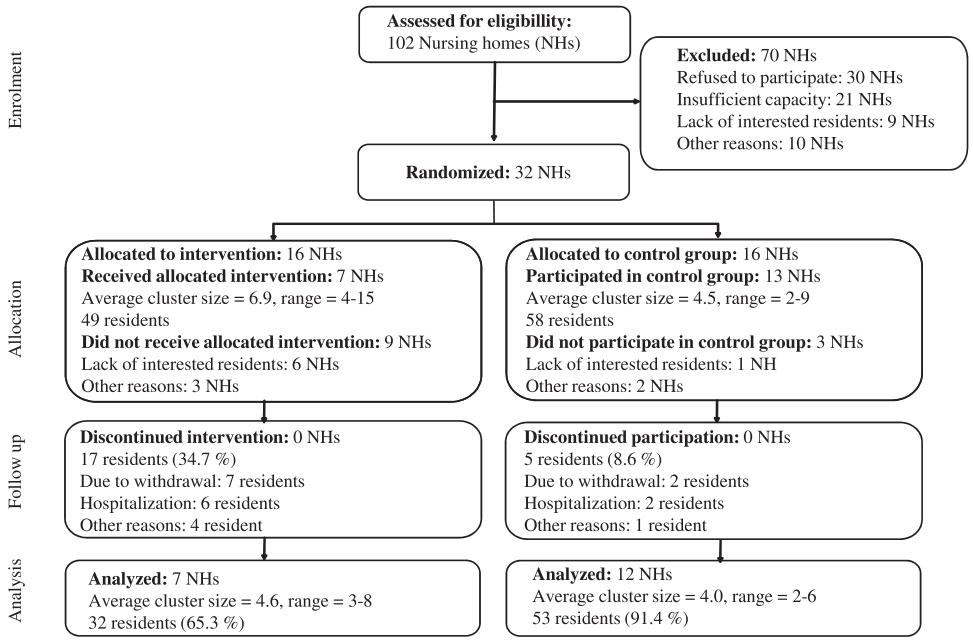


**Fig. 1.** Flow diagram of the progress of nursing homes and residents through study course. Refer to Campbell et al.[36]

quality assessed by ISI, as well as external assessment of sleep by nurses.

*Actigraphy-based sleep parameters*

Estimations of intraclass correlation coefficients yielded cluster effects for the sleep parameter time in bed (ICC = 0.132), total sleep time (ICC = 0.040), and number of nocturnal awakenings (ICC = 0.032). Intraclass correlation coefficients of the other sleep parameters (sleep efficiency, wake after sleep onset, mean awaking length and mean sleep period duration) were zero, indicating that there was no substantial variability in these variables attributable to the cluster effect (see Table 4).

Mean sleep parameters measured by actigraph are presented in Table 3. At baseline, participants in the intervention group spent 604.9 min in bed (control group: 580.0 min) on average and spent 436.6 min of this time asleep (control group: 397.2 min), resulting in an average sleep efficiency of 72.3% (control group: 68.6%). On average, participants in the intervention group awoke 20.9 times during the night at baseline (control group: 21.2) for a mean duration of 8.7 min (control group: 9.8 min). The mean duration of a sleep period was 23.5 min in this group (control group: 21.3 min). There were no significant differences in these measures between groups at baseline (data not shown). As indicated in Table 4 that shows the results of multilevel analyses, actigraphy-based sleep parameters did not improve in the intervention group compared to the control group during the study course.

*Self-reported sleep quality and nurses' ratings of residents' sleep disturbances*

Mean ISI-score in the intervention group decreased from 9.9 at baseline to 7.4 at FU 2 in comparison to no substantial decrease in the control group (9.1 at baseline and 8.6 at FU 2), indicating improved subjective sleep quality after 8 weeks of activation. The effects of the social and physical activation program on subjective sleep quality were confirmed by unadjusted multilevel analysis ($\beta = -1.09$; $p = 0.044$), as well as after controlling for baseline covariates ($\beta = -1.83$; $p = 0.004$). According to nurses' assessments, there was a slight, but statistically non-significant, trend toward an intervention effect on sleep. Considering only participants with a suboptimal rating at baseline, half of the intervention participants showed an improvement in sleep assessed by nurses after the activation program, half of the intervention participants showed no change, and no participants experienced a deterioration of sleep quality. In contrast, nurses' ratings of sleep disturbances improved in 30.6% of the control group members at FU 2 compared to baseline, 61.1% did not change, and the sleep of 8% of the control group members decreased during the study course (data not shown).

**Table 3**
Actigraphy-based sleep parameters and ISI scores during study course.

| | Intervention group | | | Control group | | |
|---|---|---|---|---|---|---|
| | Baseline | FU 1 | FU 2 | Baseline | FU 1 | FU 2 |
| Sleep efficiency (%) | 72.3 (10.7) | 72.1 (9.8) | 69.0 (9.9) | 68.6 (15.3) | 68.7 (14.1) | 67.3 (17) |
| Time in bed (min)[a] | 604.9 (112.5) | 604.0 (110.6) | 608.1 (120.9) | 580.0 (104) | 587.5 (109.4) | 582.4 (106.1) |
| Total sleep time (min) | 436.6 (110.4) | 436.5 (111) | 417.9 (103.4) | 397.2 (112.3) | 401.7 (109.4) | 392.1 (121.2) |
| Wake after sleep onset (min) | 155.3 (71.3) | 156.7 (63.9) | 175.9 (71.1) | 162.3 (79.8) | 166.3 (74.4) | 168.9 (82.4) |
| Number of awakenings | 20.9 (9.1) | 21.8 (9.2) | 22.6 (8.2) | 21.2 (7.7) | 23.0 (9) | 21.1 (7.9) |
| Mean awakening length (min) | 8.7 (3.6) | 8.7 (3.6) | 9.5 (3.9) | 9.8 (6.2) | 9.0 (5) | 10.1 (6.3) |
| Mean sleep period duration (min) | 23.5 (8.9) | 23.2 (10.7) | 20.1 (6.3) | 21.3 (10.8) | 19.7 (8.1) | 21.1 (10) |
| Insomnia Severity Index | 9.9 (6.2) | 7.5 (6.2) | 7.4 (6.1) | 9.1 (5.1) | 8.3 (5.5) | 8.6 (5.8) |

Mean and standard deviation (values in parentheses) are given.
[a] Based on sleep logs.

**Table 4**
Mixed model analysis of actigraphy-based sleep parameters and ISI score.

| | Intraclass | Unadjusted | | | Adjusted[a] | | |
|---|---|---|---|---|---|---|---|
| | Correlation | Estimate | *t* value | *p* value | Estimate | *t* value | *p* value |
| Efficiency | 0 | −0.53 | −0.50 | 0.621 | −0.54 | −0.41 | 0.680 |
| Time in bed | 0.132 | 1.89 | 0.27 | 0.785 | 1.62 | 0.19 | 0.849 |
| Total sleep time | 0.04 | −2.27 | −0.25 | 0.804 | −2.54 | −0.23 | 0.820 |
| Wake after sleep onset | 0 | 4.71 | 0.92 | 0.357 | 4.40 | 0.71 | 0.480 |
| Number of awakenings | 0.032 | 0.87 | 1.32 | 0.188 | 0.49 | 0.61 | 0.542 |
| Mean awakening length | 0 | 0.18 | 0.32 | 0.751 | 0.20 | 0.29 | 0.771 |
| Mean sleep period duration | 0 | −1.37 | −1.42 | 0.158 | −0.91 | −0.78 | 0.439 |
| Insomnia Severity Index | 0 | −1.09 | −2.02 | 0.044 | −1.83 | −2.93 | 0.004 |

[a] Adjusted for gender, age, cognitive impairments, mood, aggressive behavior, ADL score, cardiovascular disease, presence of cardiovascular diseases, diseases of the musculoskeletal system, sleep related breathing/moving disorders, sedative drug load, and participation in regular social and physical activities in the nursing home.

## Discussion

The combination of social and physical activation during the eight weeks improved subjective sleep quality of long term care residents at a clinically and statistically significant level. However, the study failed to provide evidence that participants also benefited from the intervention in terms of objective sleep parameters measured by actigraphy. This apparent contradiction can be explained by recognizing that sleep problems are subjective complaints on the basis of large individual differences in self-perception and resilience. Therefore, subjective sleep perception can diverge from objective measures of sleep to a particular degree. Another example of a non-pharmacological intervention study without an effect on objective sleep parameters, which was nevertheless successful in improving subjective sleep quality, was conducted by Benloucif et al.[9] They achieved an improvement in sleep related quality of life assessed by the Pittsburgh Sleep Quality Index (PSQI) by means of daily physical training during two weeks, whereas objective sleep parameters were not improved by the intervention.

### *Nurses' ratings of residents' sleep disturbances*

Concerning the sleep disturbances assessed by nurses, a slight positive trend, which was not statistically significant, toward improvement was observed after eight weeks of the intervention. A reason for this finding might be found in the instrument used for the external rating of sleep problems. A single item with three levels of response might not be sensitive enough to detect changes in sleep after a relatively short period of time. Another reason might be that for organizational and pragmatic reasons, baseline and follow-up assessment of residents' sleep were not always performed by the same nurse. This factor might add additional variability to the external ratings of residents' sleep.

### *Pragmatic intervention*

In the present study, a somewhat pragmatic intervention limited to 4 sessions per week and an 8-week intervention phase was designed to facilitate implementation of the activation program in routine daily care in the nursing homes. Other non-pharmacological interventions that succeeded in improving actigraphy-based sleep parameters lasted longer or were more intensive than in the present study. For example, in a small-scale randomized trial evaluating a physical mobilization program in combination with an environmental intervention, Alessi et al[8] achieved an improvement in actigraphy-measured sleep efficiency. The intervention lasted 14 weeks, which was six weeks longer than the present trial. As mentioned above, Richards et al[11] managed to improve residents' total sleep time by combining physical mobilization and social activation in a study of larger scale. The intervention of Richards et al had a length comparable to the present study (seven weeks), but it was much more intensive: the successful combination treatment comprised 1 h of occupational therapy five days each week, as well as 45 min of physical training five days each week. It may therefore be concluded that a combination of social and physical activation may noticeably improve subjective sleep quality rather quickly, but before improvements of sleep quality become objectively measurable, residents may have to be activated in a longer or more intensive way.

### *Recruitment of residents*

Despite the pragmatic approach, it was difficult to motivate the residents to participate. Because the recruitment of study participants proved to be difficult, more nursing homes had to be enrolled in the study than originally planned. Despite the inclusion of additional nursing homes, the originally intended sample size was not reached. A reason for this difficulty might be that the evaluated activation program was very demanding for residents and their physical and cognitive functioning, and only a minority of current nursing home residents could meet these demands. The requirements of the activation program regarding physical and cognitive performance, as described in the narrowly defined inclusion and exclusion criteria, restricted the number of residents who were eligible for study participation. Particularly, the exclusion of nursing home residents with more than moderate cognitive impairment hindered participant acquisition. Since the launch of nursing care insurance in Germany in 1995 that favored outpatient care over inpatient care and was consistent with demographic changes, the proportion of residents with dementia in nursing homes has continuously increased in recent years. In 2005, a prevalence rate of dementia of 68.8% among local nursing home residents was determined by a representative survey.[28] A trend toward greater numbers of nursing home residents suffering from dementia has been observed in other countries as well. The authors of a recent systematic review published in 2010 found prevalence rates between 12.0% and 95.0% for dementia, with a median of 58.0% in 30 international observational studies conducted in long term care facilities.[29] Residents with more than moderate cognitive impairment were not addressed by the activation program evaluated in the present study. However, residents with dementia often suffer from circadian rhythm disturbances, sleep fragmentation, nocturnal agitation behaviors, and excessive daytime sleepiness.[30] Beyond the scope of this study, there is also a need for precisely tailored, non-pharmacological approaches to promote sleep quality of residents with dementia.

Another challenge in recruitment was to motivate residents who met the eligibility criteria to participate in the study. It was difficult to have residents participate and to adhere to the intervention during the study course. This finding was consistent with reports from other exercise interventions disclosing low

recruitment rates and high attrition rates.[31,32] Barriers that prevent elderly people from engaging in physical activity include poor physical functioning, poor self-efficacy, less physical activity in young age, and low health expectations.[33,34] Additionally, many elderly people still have a more conservative perception of medicine and health. They are used to maintaining bed rest in case of illness, and they are less aware of the benefits of physical activity.[35] Therefore, a strategy is needed to encourage the residents' motivation in planning an activation program in nursing homes.

In addition to evaluating new approaches to motivate residents for a more active life style, future research efforts should aim to optimize non-pharmacological sleep-promoting interventions in nursing homes. A worthwhile pursuit would be to design more sustainable, enduring activation programs that can be easily integrated into residents' everyday life. Another task may be to create ways to enable various levels of participation such that residents with more severe cognitive impairment can also participate in an intervention.

### *Limitations of the study*

The present study was subject to some limitations. First, the analyses were adjusted for sedative drugs captured at baseline only. Therefore, later changes in the medication regime of study participants could have biased the results. Second, study groups were unbalanced regarding cognitive performance at baseline. However, controlling for cognitive impairment did not significantly change the results of the analyses of sleep parameters. Third, intervention participants dropped out more frequently than participants in the control group. Although the reason for this finding remained unclear, it can be assumed that a lack of motivation contributed to the high drop-out rate in the intervention group. Analysis of drop-outs revealed no significant differences between participants who discontinued the study prematurely and those who completed the study successfully. Fourth and most importantly, the intended sample size was not reached. However, the intraclass correlation coefficient of sleep efficiency indicated that there was less variation in the main target variable between the nursing homes than previously assumed, suggesting that the design effect used in the sample size calculation to allow for cluster randomization might have been overestimated.

## Conclusions

An eight-week course of social activation and physical mobilization improved subjective sleep quality of nursing home residents in a statistically significant way, especially for those without cognitive impairment. Furthermore, according to the nurses, half of the residents with sleep disturbances benefited from the intervention. However, this trend was not statistically significant. The present study also could not demonstrate an intervention effect on actigraphy-based sleep parameters. Further research should address the sustainability of interventions, strategies to encourage participants' motivation, and non-pharmacological approaches to managing sleep disturbances among residents with dementia.

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